

Appendix 4-A.

Electricity Case Studies

The following case studies, obtained by running LMOP's LFGcost economic assessment tool, are example preliminary economic assessments for a 3 megawatt (MW) landfill gas (LFG) electricity project using internal combustion engines. The first case, named "Electricity 1" is a privately funded project at a landfill that already has an LFG collection and flaring system in place. A similar case for a landfill that does not have an LFG collection and flaring system and must include collection system and flare costs in the economic assessment is named "Electricity 2." Also included are several other cases, including projects that receive revenue through greenhouse gas credits or renewable energy credits and projects that use municipal funding. The summary table below describes each case. The following pages present the actual output from [LFGcost-Web](#).

Privately Developed Projects

Case Study Name	Project Description	Financing and Revenue Elements	Financial Results Summary
Electricity 1	<ul style="list-style-type: none"> 3 MW engine project No collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% financed 8% interest rate 6¢/kWh (default) electricity price 	Capital cost: \$5,150,800 O&M cost: \$526,317 NPV: \$587,078 IRR: 14% NPV payback (years): 12
Electricity 2	<ul style="list-style-type: none"> 3 MW engine project LFG collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% financed 8% interest rate 6¢/kWh (default) electricity price 	Capital cost: \$7,631,513 O&M cost: \$884,764 NPV: (\$3,508,256) IRR: -7% NPV payback (years): none
Electricity 3	<ul style="list-style-type: none"> 3 MW engine project LFG collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% financed 8% interest rate 8.76¢/kWh electricity price calculated to achieve 10% IRR 	Capital cost: \$7,631,513 O&M cost: \$924,816 NPV: \$4,881 IRR: 10% NPV payback (years): 15
Electricity 4	<ul style="list-style-type: none"> 3 MW engine project LFG collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% financed 8% interest rate 6¢/kWh (default) electricity price \$4/metric ton carbon dioxide equivalent credit revenue included 	Capital cost: \$7,631,513 O&M cost: \$884,764 NPV: (\$62,709) IRR: 10% NPV payback (years): None
Electricity 5	<ul style="list-style-type: none"> 3 MW engine project No collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% financed 8% interest rate 6¢/kWh (default) electricity price 2¢/kWh renewable energy credit included 	Capital cost: \$5,150,800 O&M cost: \$526,317 NPV: \$2,615,488 IRR: 30% NPV payback (years): 5

Municipality-Developed Projects

Case Study Name	Project Description	Financing and Revenue Elements	Financial Results Summary
Electricity 6	<ul style="list-style-type: none"> 3 MW engine project No collection and flaring system required 	<ul style="list-style-type: none"> 100% down payment using municipal budget 6% discount rate 6¢/kWh (default) electricity price 	Capital cost: \$5,150,800 O&M cost: \$526,317 NPV: \$3,536,852 IRR: 15% NPV payback (years): 8
Electricity 7	<ul style="list-style-type: none"> 3 MW engine project No collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% bond-financed 6% interest rate, 6% discount rate 6¢/kWh (default) electricity price 	Capital cost: \$5,150,800 O&M cost: \$526,317 NPV: \$3,303,608 IRR: 24% NPV payback (years): 7
Electricity 8	<ul style="list-style-type: none"> 3 MW engine project LFG collection and flaring system required 	<ul style="list-style-type: none"> 100% down payment using municipal budget 6% discount rate 6¢/kWh (default) electricity price 	Capital cost: \$7,631,513 O&M cost: \$884,764 NPV: (\$2,553,089) IRR: 0% NPV payback (years): none
Electricity 9	<ul style="list-style-type: none"> 3 MW engine project LFG collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% bond-financed 6% interest rate, 6% discount rate 6¢/kWh (default) electricity price 	Capital cost: \$7,631,513 O&M cost: \$884,764 NPV: (\$2,898,667) IRR: -5% NPV payback (years): none
Electricity 10	<ul style="list-style-type: none"> 3 MW engine project LFG collection and flaring system required 	<ul style="list-style-type: none"> 20% down payment, 80% bond-financed 6% interest rate, 6% discount rate 7.73¢/kWh electricity price calculated to achieve 6% IRR 	Capital cost: \$7,631,513 O&M cost: \$904,064 NPV: \$3,135 IRR: 6% NPV payback (years): 15

IRR: internal rate of return

kWh: kilowatt-hour

NPV: net present value

O&M: operation and maintenance



Case Study ID: Electricity 1

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model **LFGcost, Version 2.0**

Summary Report

Landfill Name or Identifier: Private Finance

LFGE Project Type: Standard Reciprocating Engine-Generator Set

Date: Thursday, September 03, 2009

Disclaimer:

LFGcost is a landfill gas energy project cost estimating tool developed for EPA's LMOP. LFGcost estimates landfill gas generation rates using a first-order decay equation. This equation is used to estimate generation potential but can not be considered an absolute predictor of the rate of landfill gas generation. Variations in the rate and types of incoming waste, site operating conditions, and moisture and temperature conditions may provide substantial variations in the actual rates of generation.

The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year:	2011
Project End Year:	2025
Project Type:	Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	\$587,078	(at year of construction)
Internal Rate of Return:	14%	
Net Present Value Payback (yrs):	12	(years after operation begins)
Installed Capital Costs:		

Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775
Electrical Interconnect Equipment:	\$255,025
Total Capital Costs:	\$5,150,800

O&M Costs:	\$526,317	(for initial year of operation)
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These financial results DO NOT include the costs associated with the LFG collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):

Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 8.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: 35.0%

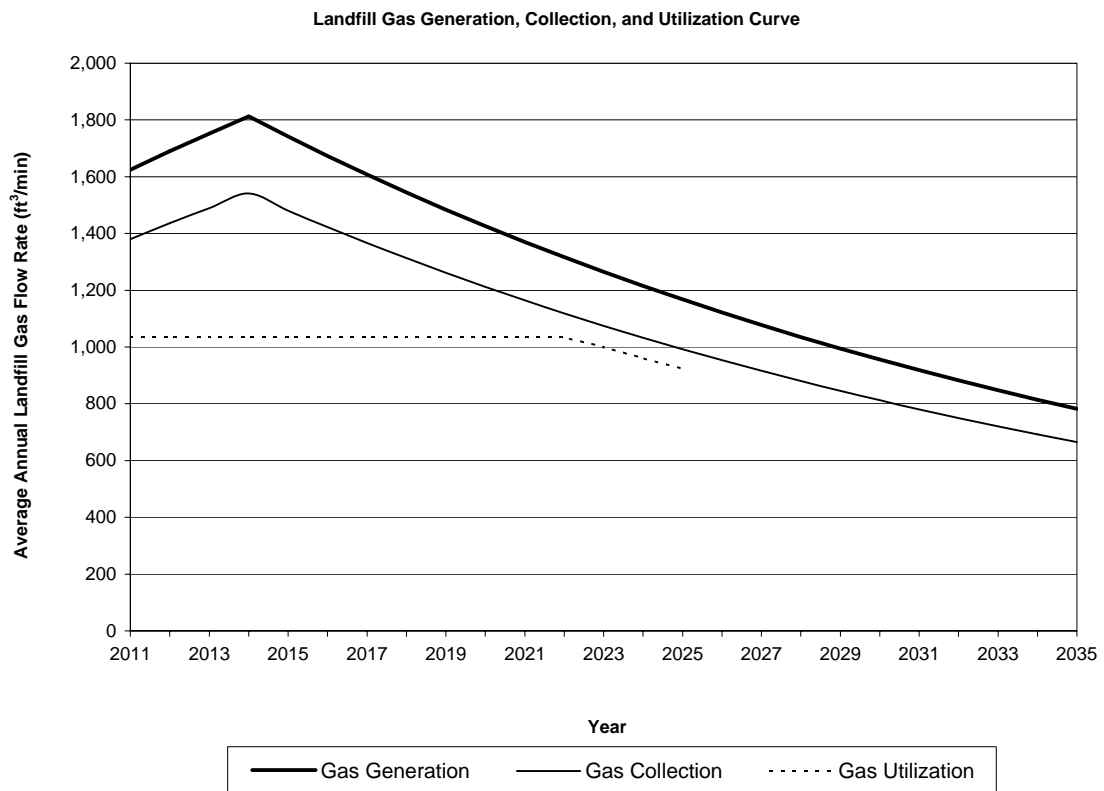
Discount Rate: 10.0%

Down Payment: 20.0%

Collection and Flaring Costs: NOT Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 2

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model LFGcost, Version 2.0

Summary Report

Landfill Name or Identifier: Private Finance
Including Costs for Gas Collection and Flare
LFGE Project Type: Standard Reciprocating Engine-Generator Set
Date: Thursday, September 03, 2009

Disclaimer:

LFGcost is a landfill gas energy project cost estimating tool developed for EPA's LMOP. LFGcost estimates landfill gas generation rates using a first-order decay equation. This equation is used to estimate generation potential but can not be considered an absolute predictor of the rate of landfill gas generation. Variations in the rate and types of incoming waste, site operating conditions, and moisture and temperature conditions may provide substantial variations in the actual rates of generation.

The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year:	2011	
Project End Year:	2025	
Project Type:	Standard Reciprocating Engine-Generator Set	
Financial Results:		
Net Present Value:	(\$3,508,256)	(at year of construction)
Internal Rate of Return:	-7%	
Net Present Value Payback (yrs):	None	(years after operation begins)
Installed Capital Costs:		
Gas Collection and Flare:	\$2,480,713	
Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775	
Electrical Interconnect Equipment:	\$255,025	
Total Capital Costs:	\$7,631,513	
O&M Costs:	\$884,764	(for initial year of operation)

These financial results include the costs associated with the gas collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):
Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 8.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: 35.0%

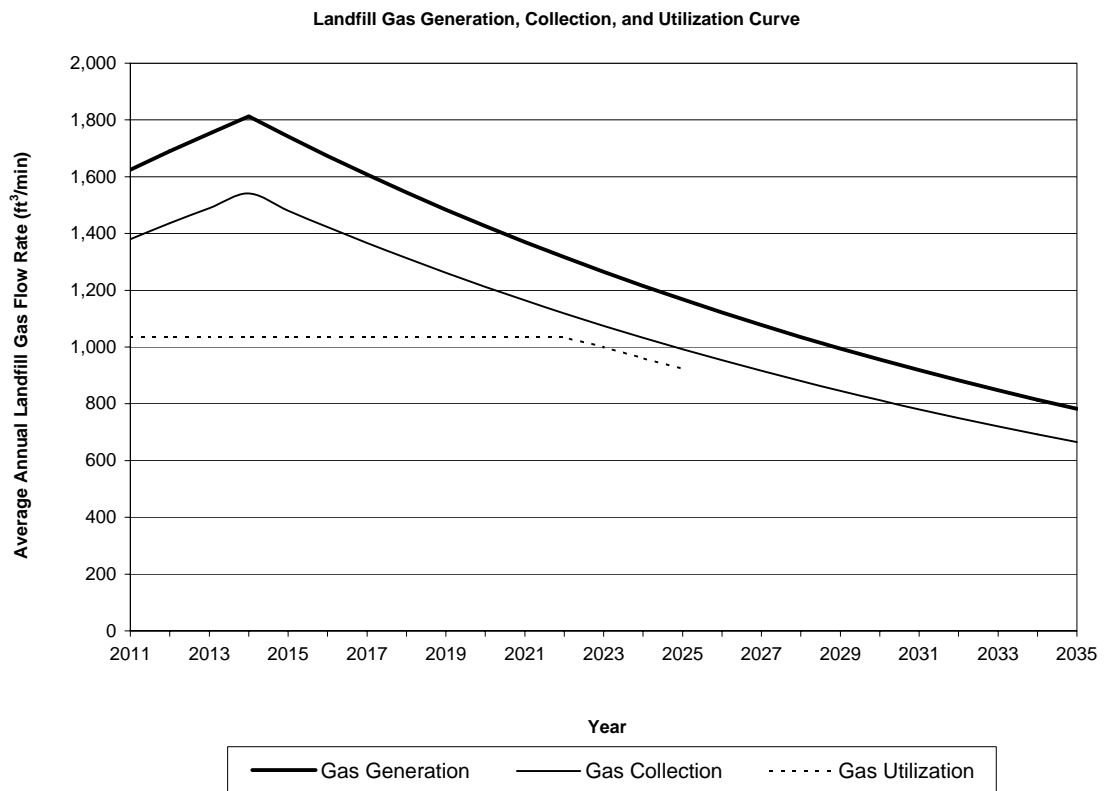
Discount Rate: 10.0%

Down Payment: 20.0%

Collection and Flaring Costs: Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 3

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model LFGcost, Version 2.0

Summary Report

Landfill Name or Identifier: Private Finance at Break Even Electricity Price
Including Costs for Gas Collection and Flare

LFGE Project Type: Standard Reciprocating Engine-Generator Set

Date: Thursday, September 03, 2009

Disclaimer:

LFGcost is a landfill gas energy project cost estimating tool developed for EPA's LMOP. LFGcost estimates landfill gas generation rates using a first-order decay equation. This equation is used to estimate generation potential but can not be considered an absolute predictor of the rate of landfill gas generation. Variations in the rate and types of incoming waste, site operating conditions, and moisture and temperature conditions may provide substantial variations in the actual rates of generation.

The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year:	2011
Project End Year:	2025
Project Type:	Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	\$4,881	(at year of construction)
Internal Rate of Return:	10%	
Net Present Value Payback (yrs):	15	(years after operation begins)
Installed Capital Costs:		
Gas Collection and Flare:	\$2,480,713	
Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775	
Electrical Interconnect Equipment:	\$255,025	
Total Capital Costs:	\$7,631,513	
O&M Costs:	\$924,816	(for initial year of operation)

These financial results include the costs associated with the gas collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):
Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 8.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: 35.0%

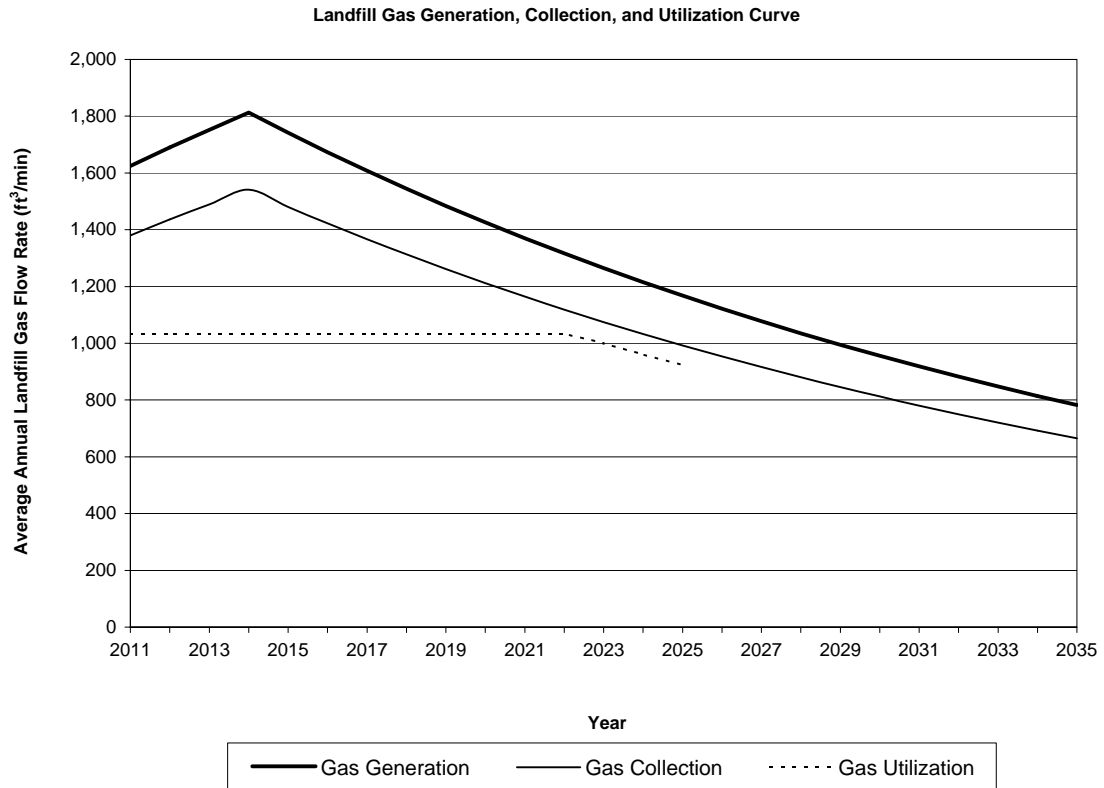
Discount Rate: 10.0%

Down Payment: 20.0%

Collection and Flaring Costs: Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Price to Achieve Financial Goals (\$/kWh):	0.0876	<i>(determined by Financial Goals Calculator results)</i>





Case Study ID: Electricity 4

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model LFGcost, Version 2.0

Summary Report

Landfill Name or Identifier: Private Finance with CO2 Credit
Including Costs for Gas Collection and Flare
LFGE Project Type: Standard Reciprocating Engine-Generator Set
Date: Thursday, September 03, 2009

Disclaimer:

LFGcost is a landfill gas energy project cost estimating tool developed for EPA's LMOP. LFGcost estimates landfill gas generation rates using a first-order decay equation. This equation is used to estimate generation potential but can not be considered an absolute predictor of the rate of landfill gas generation. Variations in the rate and types of incoming waste, site operating conditions, and moisture and temperature conditions may provide substantial variations in the actual rates of generation.

The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year:	2011	
Project End Year:	2025	
Project Type:	Standard Reciprocating Engine-Generator Set	
Financial Results:		
Net Present Value:	(\$62,709)	(at year of construction)
Internal Rate of Return:	10%	
Net Present Value Payback (yrs):	None	(years after operation begins)
Installed Capital Costs:		
Gas Collection and Flare:	\$2,480,713	
Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775	
Electrical Interconnect Equipment:	\$255,025	
Total Capital Costs:	\$7,631,513	
O&M Costs:	\$884,764	(for initial year of operation)

These financial results include the costs associated with the gas collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):

Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 8.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: 35.0%

Discount Rate: 10.0%

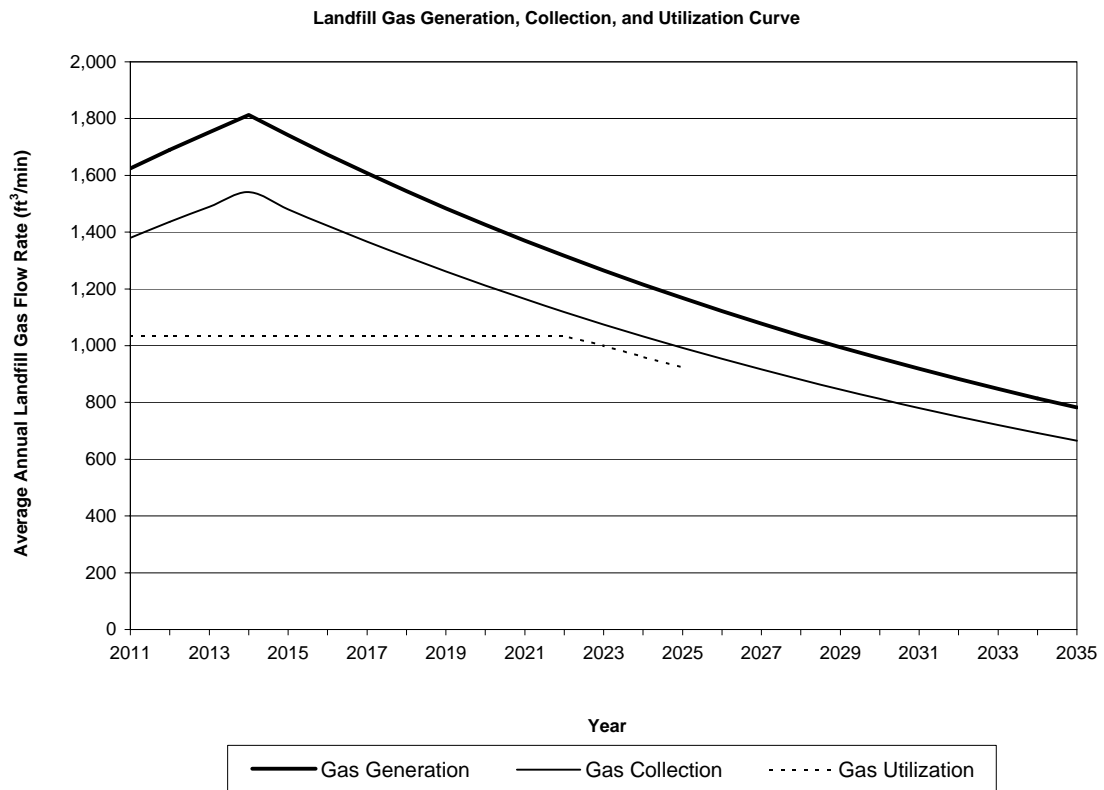
Down Payment: 20.0%

Collection and Flaring Costs: Included

CO2 Emission Reduction Credit (\$/MTCO₂E): \$4.00

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 5

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model **LFGcost, Version 2.0**

Summary Report

Landfill Name or Identifier: Private Finance with Renewable Electricity Credit (REC)

LFGE Project Type: Standard Reciprocating Engine-Generator Set

Date: Thursday, September 03, 2009

Disclaimer:

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The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year:	2011
Project End Year:	2025
Project Type:	Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	\$2,615,488	(at year of construction)
Internal Rate of Return:	30%	
Net Present Value Payback (yrs):	5	(years after operation begins)
Installed Capital Costs:		

Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775
Electrical Interconnect Equipment:	\$255,025
Total Capital Costs:	\$5,150,800

O&M Costs:	\$526,317	(for initial year of operation)
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These financial results DO NOT include the costs associated with the LFG collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):
Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 8.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: 35.0%

Discount Rate: 10.0%

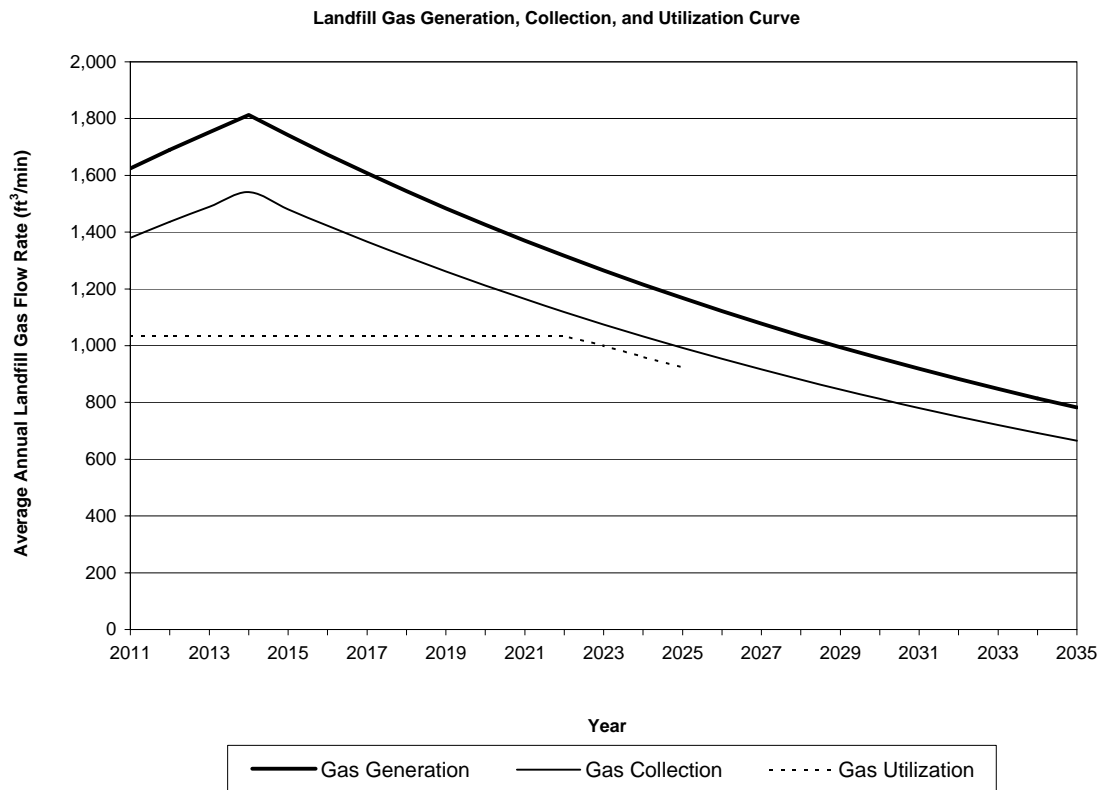
Down Payment: 20.0%

Collection and Flaring Costs: NOT Included

Renewable Electricity Credit (\$/kWh): \$0.02

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 6

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model **LFGcost, Version 2.0**

Summary Report

Landfill Name or Identifier: Municipal Budget Finance

LFGE Project Type: Standard Reciprocating Engine-Generator Set

Date: Thursday, September 03, 2009

Disclaimer:

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Summary Results

Project Start Year:	2011
Project End Year:	2025
Project Type:	Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	\$3,536,852	(at year of construction)
Internal Rate of Return:	15%	
Net Present Value Payback (yrs):	8	(years after operation begins)
Installed Capital Costs:		

Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775
Electrical Interconnect Equipment:	\$255,025
Total Capital Costs:	\$5,150,800

O&M Costs:	\$526,317	(for initial year of operation)
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These financial results DO NOT include the costs associated with the LFG collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):
Annual Average: 1,019

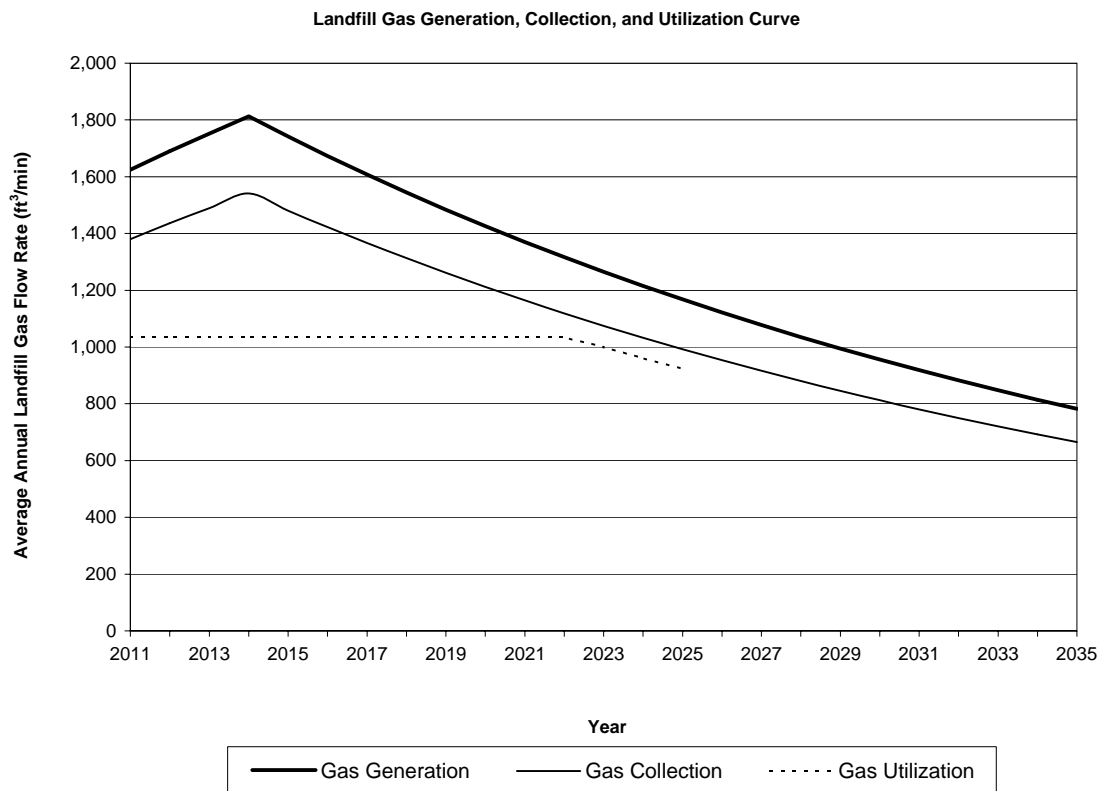
LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years):	Not Applicable
Interest Rate:	Not Applicable
General Inflation Rate:	2.5% <i>(applied to O&M costs)</i>
Equipment Inflation Rate:	1.0%
Marginal Tax Rate:	Not Applicable
Discount Rate:	6.0%
Down Payment:	100.0%
Collection and Flaring Costs:	NOT Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 7

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model **LFGcost, Version 2.0**

Summary Report

Landfill Name or Identifier: Municipal Bond Finance

LFGE Project Type: Standard Reciprocating Engine-Generator Set

Date: Thursday, September 03, 2009

Disclaimer:

LFGcost is a landfill gas energy project cost estimating tool developed for EPA's LMOP. LFGcost estimates landfill gas generation rates using a first-order decay equation. This equation is used to estimate generation potential but can not be considered an absolute predictor of the rate of landfill gas generation. Variations in the rate and types of incoming waste, site operating conditions, and moisture and temperature conditions may provide substantial variations in the actual rates of generation.

The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year:	2011
Project End Year:	2025
Project Type:	Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	\$3,303,608	(at year of construction)
Internal Rate of Return:	24%	
Net Present Value Payback (yrs):	7	(years after operation begins)
Installed Capital Costs:		

Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775
Electrical Interconnect Equipment:	\$255,025
Total Capital Costs:	\$5,150,800

O&M Costs:	\$526,317	(for initial year of operation)
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These financial results DO NOT include the costs associated with the LFG collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):
Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 6.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: Not Applicable

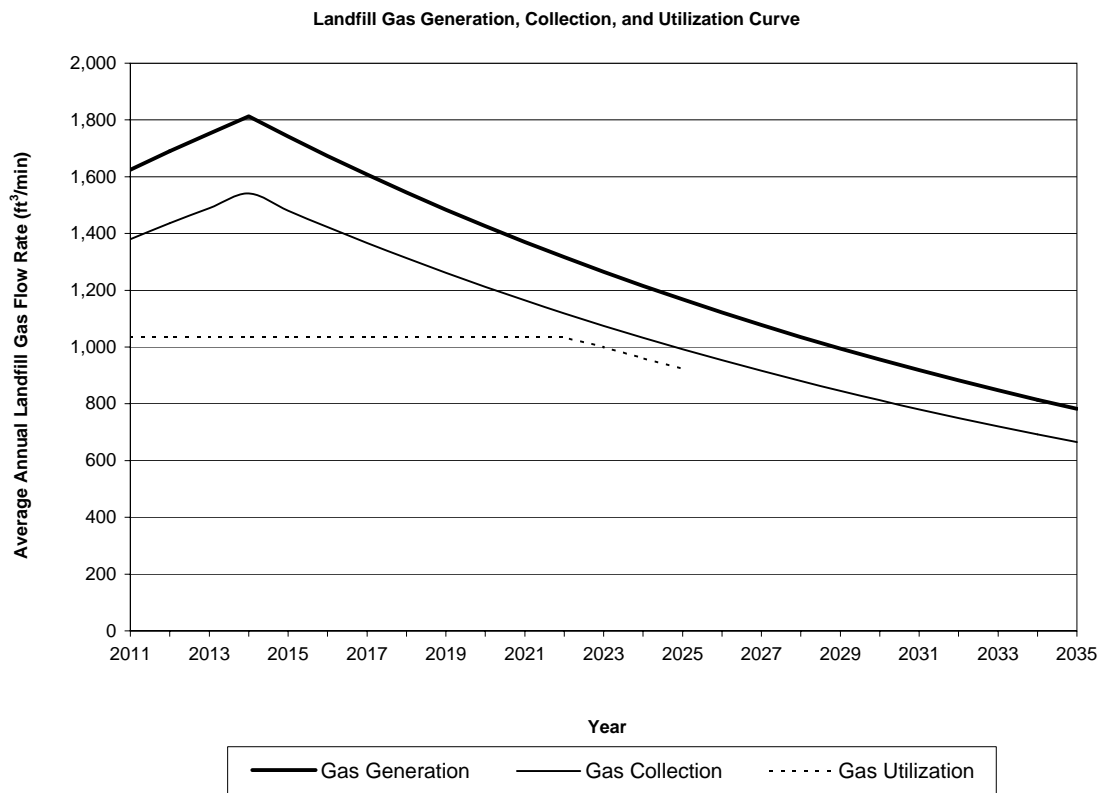
Discount Rate: 6.0%

Down Payment: 20.0%

Collection and Flaring Costs: NOT Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 8

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model LFGcost, Version 2.0

Summary Report

Landfill Name or Identifier: Municipal Budget Finance
Including Costs for Gas Collection and Flare
LFGE Project Type: Standard Reciprocating Engine-Generator Set
Date: Thursday, September 03, 2009

Disclaimer:

LFGcost is a landfill gas energy project cost estimating tool developed for EPA's LMOP. LFGcost estimates landfill gas generation rates using a first-order decay equation. This equation is used to estimate generation potential but can not be considered an absolute predictor of the rate of landfill gas generation. Variations in the rate and types of incoming waste, site operating conditions, and moisture and temperature conditions may provide substantial variations in the actual rates of generation.

The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year: 2011
Project End Year: 2025
Project Type: Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	(\$2,553,089)	(at year of construction)
Internal Rate of Return:	0%	
Net Present Value Payback (yrs):	None	(years after operation begins)
Installed Capital Costs:		
Gas Collection and Flare:	\$2,480,713	
Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775	
Electrical Interconnect Equipment:	\$255,025	
Total Capital Costs:	\$7,631,513	
O&M Costs:	\$884,764	(for initial year of operation)

These financial results include the costs associated with the gas collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):
Annual Average: 1,019

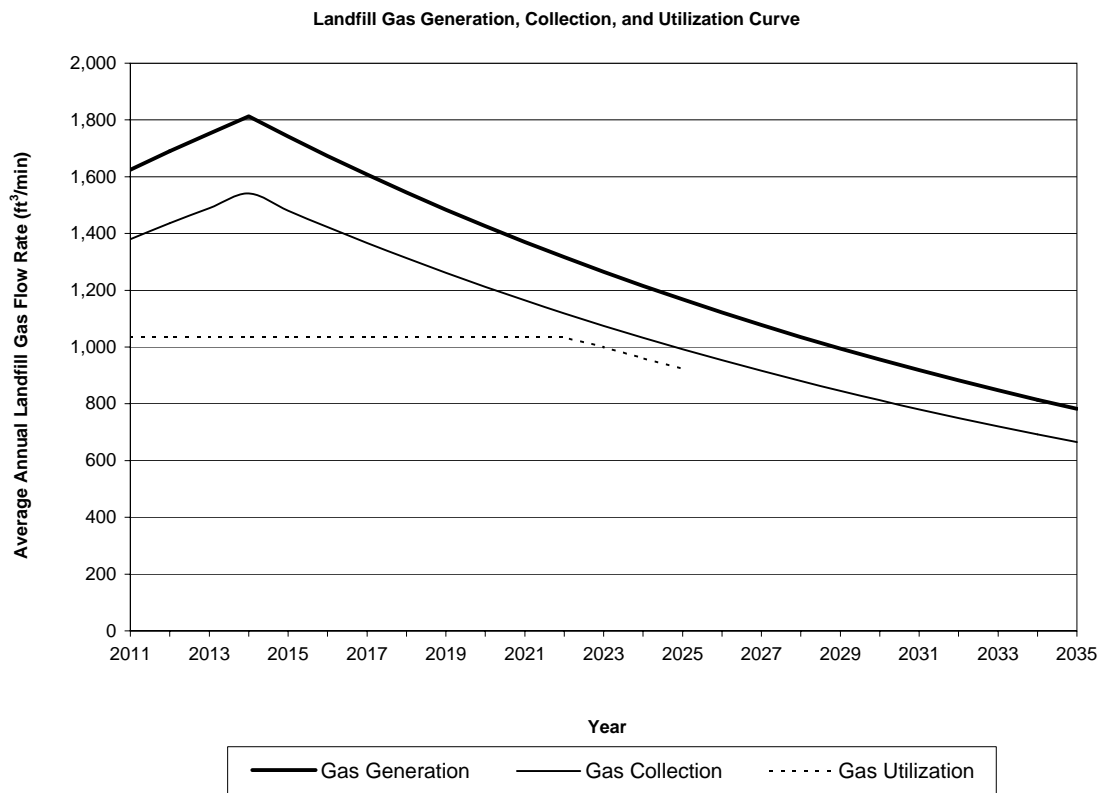
LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years):	Not Applicable
Interest Rate:	Not Applicable
General Inflation Rate:	2.5% <i>(applied to O&M costs)</i>
Equipment Inflation Rate:	1.0%
Marginal Tax Rate:	Not Applicable
Discount Rate:	6.0%
Down Payment:	100.0%
Collection and Flaring Costs:	Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 9

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model LFGcost, Version 2.0

Summary Report

Landfill Name or Identifier: Municipal Bond Finance
Including Costs for Gas Collection and Flare
LFGE Project Type: Standard Reciprocating Engine-Generator Set
Date: Thursday, September 03, 2009

Disclaimer:

LFGcost is a landfill gas energy project cost estimating tool developed for EPA's LMOP. LFGcost estimates landfill gas generation rates using a first-order decay equation. This equation is used to estimate generation potential but can not be considered an absolute predictor of the rate of landfill gas generation. Variations in the rate and types of incoming waste, site operating conditions, and moisture and temperature conditions may provide substantial variations in the actual rates of generation.

The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year: 2011
Project End Year: 2025
Project Type: Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	(\$2,898,667)	(at year of construction)
Internal Rate of Return:	-5%	
Net Present Value Payback (yrs):	None	(years after operation begins)
Installed Capital Costs:		
Gas Collection and Flare:	\$2,480,713	
Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775	
Electrical Interconnect Equipment:	\$255,025	
Total Capital Costs:	\$7,631,513	
O&M Costs:	\$884,764	(for initial year of operation)

These financial results include the costs associated with the gas collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):

Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 6.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: Not Applicable

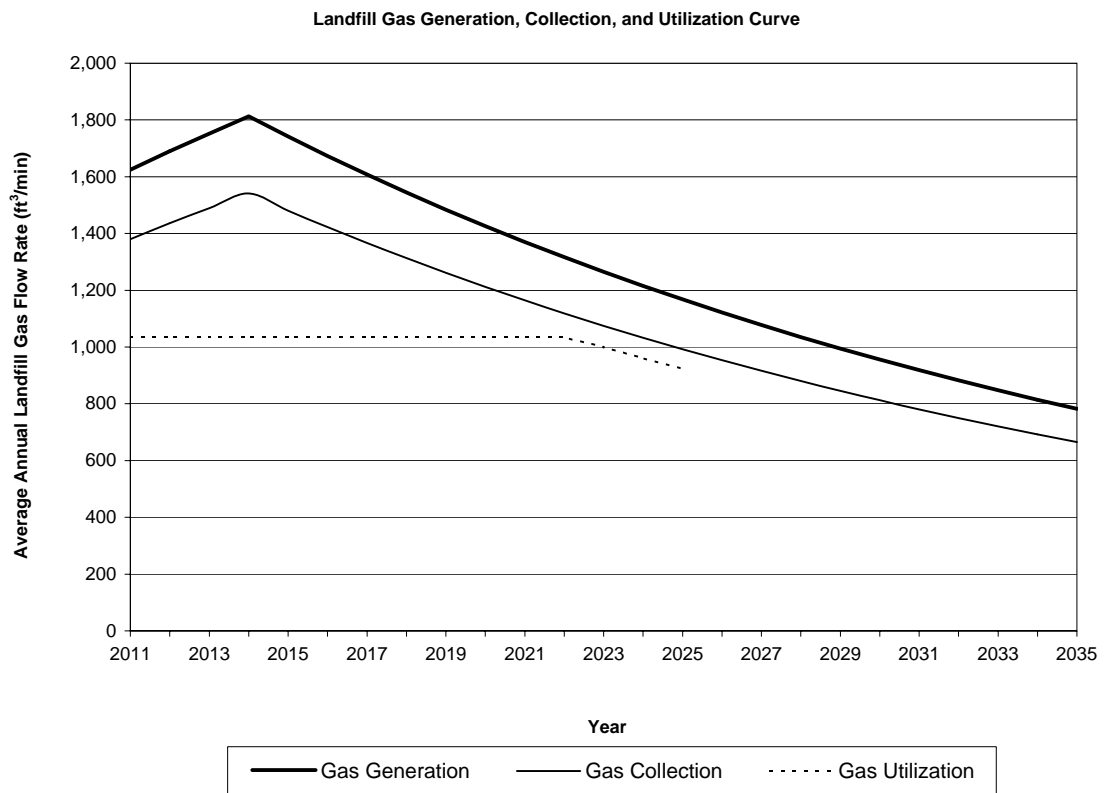
Discount Rate: 6.0%

Down Payment: 20.0%

Collection and Flaring Costs: Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	<i>(during the life of the project)</i>
Initial Year Electricity Price (\$/kWh):	0.060	





Case Study ID: Electricity 10

U.S. EPA Landfill Methane Outreach Program

Landfill Gas Energy Cost Model LFGcost, Version 2.0

Summary Report

Landfill Name or Identifier: Municipal Bond Finance at Break Even Electricity Price
Including Costs for Gas Collection and Flare

LFGE Project Type: Standard Reciprocating Engine-Generator Set

Date: Thursday, September 03, 2009

Disclaimer:

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The costs that are estimated by LFGcost are based on typical project designs and for typical landfill situations. The model attempts to include all equipment, site work, permits, operating activities, and maintenance that would normally be required for constructing and operating a typical project. However, individual landfills may require unique design modifications which would add to the cost estimated by LFGcost.

Analyses performed using LFGcost are considered preliminary and should be used for guidance only. A detailed final feasibility assessment should be conducted by qualified landfill gas professionals prior to preparing a system design, initiating construction, purchasing materials, or entering into agreements to provide or purchase energy from a landfill gas project.

Summary Results

Project Start Year:	2011
Project End Year:	2025
Project Type:	Standard Reciprocating Engine-Generator Set

Financial Results:

Net Present Value:	\$3,135	(at year of construction)
Internal Rate of Return:	6%	
Net Present Value Payback (yrs):	15	(years after operation begins)
Installed Capital Costs:		
Gas Collection and Flare:	\$2,480,713	
Gas Compression/Treatment, Engine/Generator, Site Work, and Housings:	\$4,895,775	
Electrical Interconnect Equipment:	\$255,025	
Total Capital Costs:	\$7,631,513	
O&M Costs:	\$904,064	(for initial year of operation)

These financial results include the costs associated with the gas collection and flaring system.

Environmental Benefits**Benefits from Collecting and Destroying Methane (during the life of the project):**

Lifetime	(million ft ³ methane):	5,068
	(MMTCO ₂ E):	2.04E+00
Average Annual	(million ft ³ methane/yr):	338
	(MMTCO ₂ E/yr):	1.36E-01

Benefits from Avoided Electricity Generation from Fossil Fuels (during the life of the project):

Lifetime (MMTCO ₂ E):	2.41E-01
Average Annual (MMTCO ₂ E/yr):	1.61E-02

Landfill Characteristics

Open Year:	1994
Closure Year:	2014
Waste-In-Place at Closure (tons)	5,400,000
Average Waste Acceptance (tons/yr):	270,000
Average Depth of Landfill Waste (ft):	50
Area of LFG Wellfield to Supply Project (acres):	110

Landfill Gas Generation, Collection, and Utilization**Modeling Parameters for First-Order Decay Equation:**

Methane Generation Rate, k (1/yr):	0.040
Methane Generation Capacity, L _o (ft ³ /ton):	3,204
Methane Content of LFG:	50%

Generated During Project Lifetime (ft³/min):

Minimum:	1,167
Annual Average:	1,513
Maximum:	1,813

Collected During Project Lifetime (ft³/min):

Minimum:	992
Annual Average:	1,286
Maximum:	1,541

Project Size: Defined by User

Design Flow Rate for Project (ft³/min): 1,112

Utilized by Project (ft³/min):
Annual Average: 1,019

LFG Collection Efficiency: 85%

Financial Assumptions

Loan Lifetime (years): 10

Interest Rate: 6.0%

General Inflation Rate: 2.5% *(applied to O&M costs)*

Equipment Inflation Rate: 1.0%

Marginal Tax Rate: Not Applicable

Discount Rate: 6.0%

Down Payment: 20.0%

Collection and Flaring Costs: Included

Electricity Production and Sales Summary

Total Generation Capacity (kW):	3,000	
Average Generation (million kWh/yr):	22.407	(during the life of the project)
Price to Achieve Financial Goals (\$/kWh):	0.073	(determined by Financial Goals Calculator results)

